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PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

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Applicant's or agent's file reference PCT04-023	FOR FURTHER ACTION		See Form PCT/IPEA/416
International application No. PCT/KR2004/000750	International filing date(day/month/year) 31 MARCH 2004 (31.03.2004)	Priority date (day/month/year) 17 JUNE 2003 (17.06.2003)	
International Patent Classification (IPC) or national classification and IPC IPC7 H01M 10/40			
Applicant SAMSHIN CREATION Co., Ltd. et al			

- This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 3 sheets, including this cover sheet.
- This report is also accompanied by ANNEXES, comprising:
 - ☒ (sent to the applicant and to the International Bureau) a total of 3 sheets, as follows:
 - ☒ sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
 - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
 - ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) _____ containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box relating to Sequence Listing (see Section 802 of the Administrative Instructions).

- This report contains indications relating to the following items:
 - ☒ Box No. I Basis of the report
 - ☐ Box No. II Priority
 - ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
 - ☐ Box No. IV Lack of unity of invention
 - ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
 - ☐ Box No. VI Certain documents cited
 - ☐ Box No. VII Certain defects in the international application
 - ☐ Box No. VIII Certain observations on the international application

Date of submission of the demand 17 JANUARY 2005 (17.01.2005)	Date of completion of this report 27 SEPTEMBER 2005 (27.09.2005)
Name and mailing address of the IPEA/KR  Korean Intellectual Property Office 920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer KIM, Seung Soo Telephone No. 82-42-481-5581 

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/KR2004/000750

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

- ☒ This report is based on translations from the original language into the following language English which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
- ☒ publication of the international application (under Rule 12.4)
- ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

- ☐ the international application as originally filed/furnished
- ☒ the description:
 pages 1-5, 7, 9-25 as originally filed/furnished
 pages* 6, 8 received by this Authority on 17/01/2005
 pages* _____ received by this Authority on _____
- ☒ the claims:
 pages 27-28 as originally filed/furnished
 pages* _____ as amended (together with any statement) under Article 19
 pages* 26 received by this Authority on 17/01/2005
 pages* _____ received by this Authority on _____
- ☐ the drawings:
 pages _____ as originally filed/furnished
 pages* _____ received by this Authority on _____
 pages* _____ received by this Authority on _____
- ☐ the sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to sequence listing (*specify*): _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to sequence listing (*specify*): _____

* If item 4 applies, some or all of those sheets may be marked "superseded."

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/KR2004/000750

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims		YES
	Claims	1-10	NO
Inventive step (IS)	Claims		YES
	Claims	1-10	NO
Industrial applicability (IA)	Claims	1-10	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The claimed invention relates to a complex membrane for an electrochemical device such as lithium secondary battery, manufacturing of the membrane and an electrochemical device having the above membrane. This invention also includes the complex membrane for electrochemical device of a polyolefin fine-porous membrane and a porous membrane of nano fiber on a web and united to one surface of the polyolefin fine-porous membrane.

Following document has been cited in the International Search Report:

D1 : JP12-212323(ASHAHI CHEM IND CO LTD) 2 August 2000

D1 discloses a finely porous polyolefin-based membrane having an elongated cycle life without damaging a battery-assembling property and useful as separators for lithium ion secondary batteries which can stably be used for a long period, by forming a membrane structure having a specific average pore diameter and a specified average surface pore diameter. This finely porous polyolefin-based membrane has an average pore diameter of 0.01-0.2 μm and an average pore diameter of 0.5-2 μm on at least one of the surfaces. The finely porous polyolefin-based membrane preferably has a porosity of 30-70% and a thickness of 10-80 μm . The finely porous polyolefin-based membrane is preferably obtained by orienting the membrane layer A in one direction to form a membrane layer B, and then laminating the membrane layer A to the membrane layer B to form the laminate structure.

The present invention is considered to be industrial applicable.

However, the claims 1-10 are considered to be lack of novelty and inventive step over the admitted prior art of "finely porous polyolefin-based separator "(D1).

polyolefin membrane, and a web-phase porous membrane united to at least one side of the micro-porous polyolefin membrane and composed of nano-fibers.

In the complex membrane, it is preferred that the micro-porous polyolefin membrane is a membrane having at least one layer composed of polyethylene polymer and/or polypropylene polymer, and the micro-porous polyolefin membrane preferably
5 has a thickness of 5 to 50 μm and a porosity of 30 to 80%.

In addition, the nano-fiber preferably has a diameter of 50 to 2,000 nm, and the nano-fiber is also preferably made of polymer selected from the group consisting of PVDF [poly(vinylidene fluoride)], P(VDF-HFP)
10 [poly(vinylidene)-co-(hexafluoropropylene)], PAN [poly(acrylonitrile)], P(VDF-AN) [poly(vinylidene)-co-(acrylonitrile)] copolymer, PEO [poly(ethylene oxide)], PU [poly(urethane)], poly(methylacrylate), PMMA [poly(methyl methacrylate)], PAA [poly(acrylamide)], PVC [poly(vinyl chloride)], PVAc [poly(vinylacetate)], poly(vinylpyrrolidone), polytetraethylene glycol diacrylate, PEGDMA [poly(ethylene glycol dimethacrylate)], cellulose, cellulose acetate, and their mixtures.
15

In another aspect of the invention, the complex membrane is manufactured using the steps: (a) preparing a micro-porous polyolefin membrane; (b) laminating a web-phase porous membrane made of nano-fibers on at least one surface of the micro-porous polyolefin membrane; and (c) uniting the micro-porous polyolefin
20 membrane with the web-phase porous membrane by applying predetermined pressure and temperature to the result of the step (b). Preferably, the web-phase porous membrane made of nano-fibers may be formed on one surface of the micro-porous membrane by directly spinning a polymer solution by means of electrospinning.

membrane such as thermal shrinkage should be small. In addition, considering the stability problem such as explosion of the battery, the membrane is preferably configured as a support body to have a shutdown function so that pores may be closed at a specific temperature. Here, the term 'shutdown function' is a means for controlling thermal runaway which may be caused by physical damage of the battery, short due to internal defects or overcharging, or the like. By using the shutdown function, most of the pores are closed at a specific temperature (90 to 120°C), thereby blocking ion or current flow. As a material for forming the membrane capable of accomplishing such function, polyolefin polymer is suitable. For example, a PP/PE/PP membrane is provided with the shutdown function since a PE layer is melted at a specific temperature to close pores. Polyolefin polymer suitable for the complex membrane of the present invention includes polyethylene polymer and polypropylene polymer, and may use, for example, a porous polyolefin membrane film or nonwoven fabric, a complex composition in which the same kind of nonwoven fabric is laminated on a film, a porous polyamide membrane film or nonwoven fabric, or a porous polyester membrane film or nonwoven fabric, each having a single PE membrane, a single PP membrane, a PE/PP two-layer membrane, a PP/PE/PP three-layer membrane or a complex multi-layer structure composed of PE and PP, which is monoaxial-oriented or biaxial-oriented. Preferably, a porous polyolefin membrane film of a single PE membrane, a PE/PP two-layer membrane or a PP/PE/PP three-layer membrane, which has the shutdown function for prevention of short-circuit between both electrodes, is used. This micro-porous polyolefin membrane may be manufactured according to any conventional method disclosed in EP 1,146,577, US 6,368,742, US 5,691,077, US 6,180,280, US

What is claimed is:

1. A complex membrane for an electrochemical device, comprising:
a micro-porous polyolefin membrane; and
5 a web-phase porous membrane united to at least one side of the micro-porous
polyolefin membrane and composed of nano-fibers.

2. The complex membrane according to claim 1,
wherein the micro-porous polyolefin membrane is a membrane having at least
10 one layer composed of polyethylene polymer and/or polypropylene polymer.

3. The complex membrane according to claim 1,
wherein the micro-porous polyolefin membrane has a thickness of 5 to 50 μm
and a porosity of 30 to 80%.

15 4. The complex membrane according to claim 1,
wherein the nano-fiber has a diameter of 50 to 2,000 nm.

20 5. The complex membrane according to any of claims 1 to 4,
wherein the nano-fiber is made of polymer selected from the group consisting of
poly(vinylidene fluoride) (PVDF), poly(vinylidene)-co-(hexafluoropropylene)
[P(VDF-HFP)], poly(acrylonitrile) (PAN), poly(vinylidene)-co-(acrylonitrile)
[P(VDF-AN)] copolymer, poly(ethylene oxide) (PEO), poly(urethane) (PU),